

Impact of Carrier Foil Configurations on the Reliability of Multiwire TWILL Interconnection technology for Si solar cells

Hamed Javanbakht Lomeri^{1,2,3}, Jonathan Govaerts^{1,2,3}, Bart Reekmans^{1,2,3}, Dominique Jousset⁴, Tom Borgers^{1,2,3}, Bin Luo^{1,2,3}, Yi Zheng⁵, Engin Özkol⁵, Olindo Isabella⁵, Hariharsudan Sivaramakrishnan Radhakrishnan^{1,2,3}

¹imec- imo-imomec, Genk, Belgium ²Hasselt University, imo-imomec, Hasselt, Belgium ³EnergyVille, imo-imomec, Genk, Belgium
⁴Arkema, Colombes, France ⁵Photovoltaic Materials and Devices group, Delft University of Technology, Netherlands
 Contacts: hamed.javanbakhtlomeri@imec.be

Summary

This study explores the reliability of TWILL technology, an innovative module interconnection method that simplifies solar module fabrication by embedding solder-coated copper wires into multi-layered polymeric encapsulant based foils, eliminating traditional stringing and bussing steps. Various configurations of carrier foils reinforced with glass fibers (GF) and glass beads (GB)—incorporated in core, outer, or both layers—were evaluated under thermal cycling (TC) tests for silicon heterojunction (SHJ) modules. Modules with GF foils showed <2% FF loss after 600 cycles (3× IEC), confirming high reliability.

Motivation

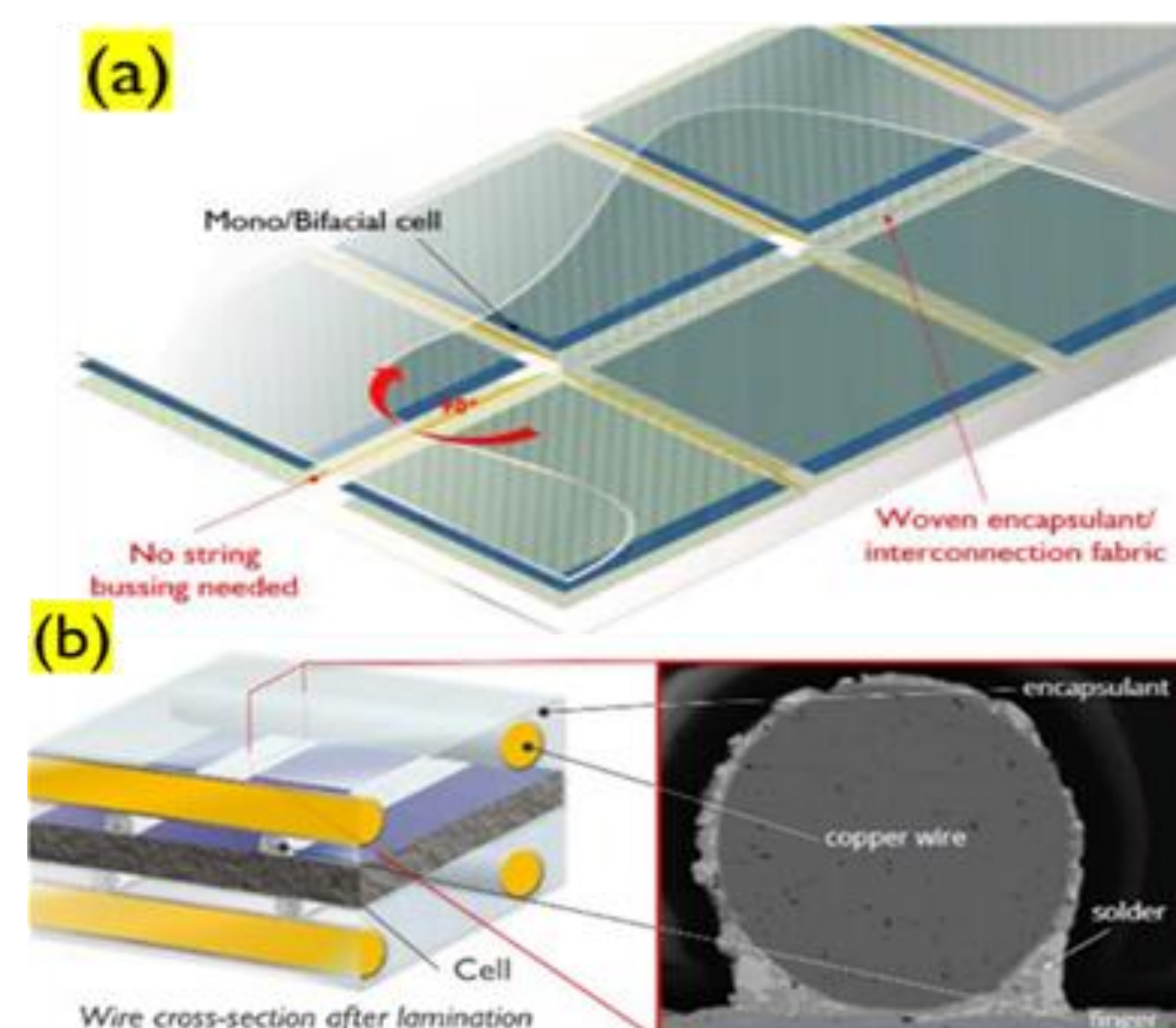
TWILL Technology*:

- Multiwire (MW) interconnection method embedding conductive copper wires in polymeric carrier foils.
- Interconnection to cell metallization occurs during lamination.
- Eliminates traditional stringing and bussing steps.

Reliability Enhancement:

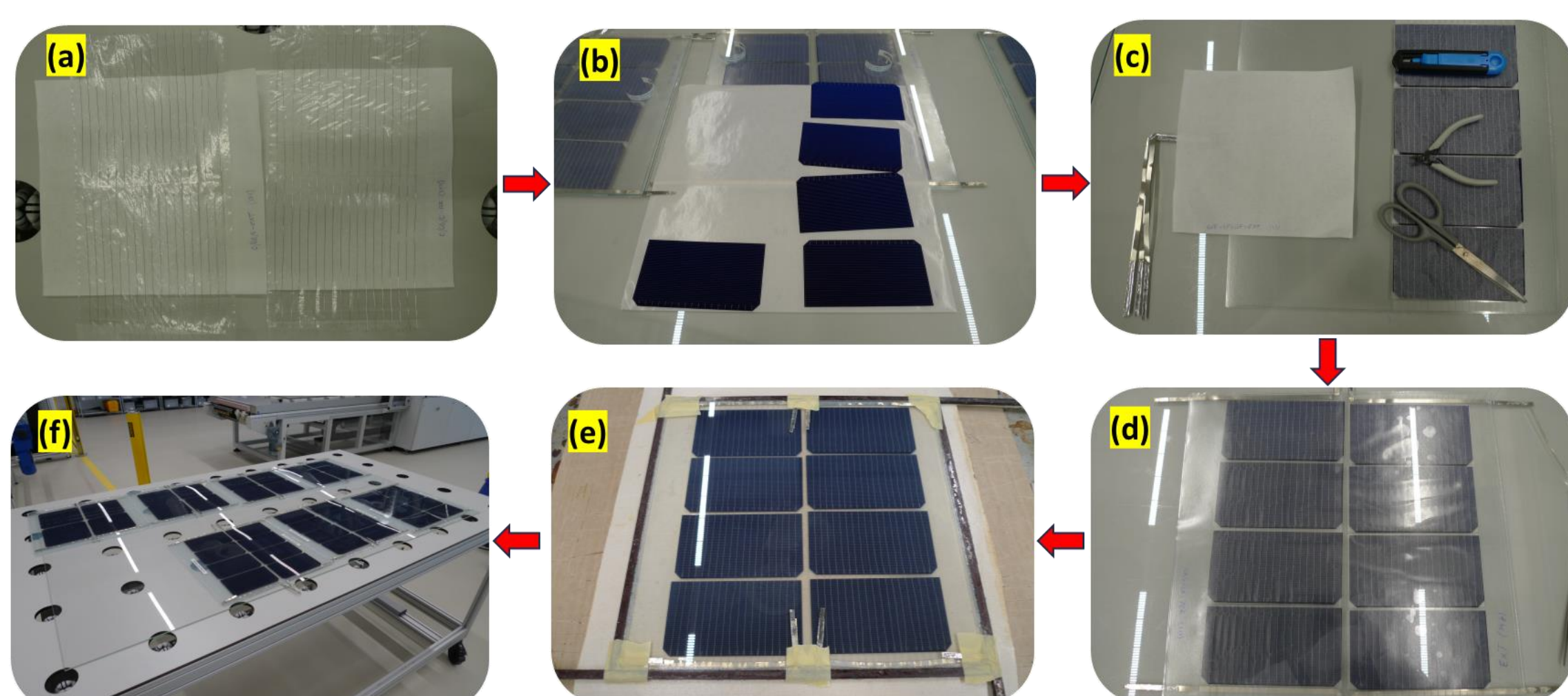
- GF in foils reduce thermal stress on solder joints due to lower thermal expansion.
- This study investigates GB as an isotropic alternative for improved thermo-mechanical stability.

* Patented: EP3790059A1

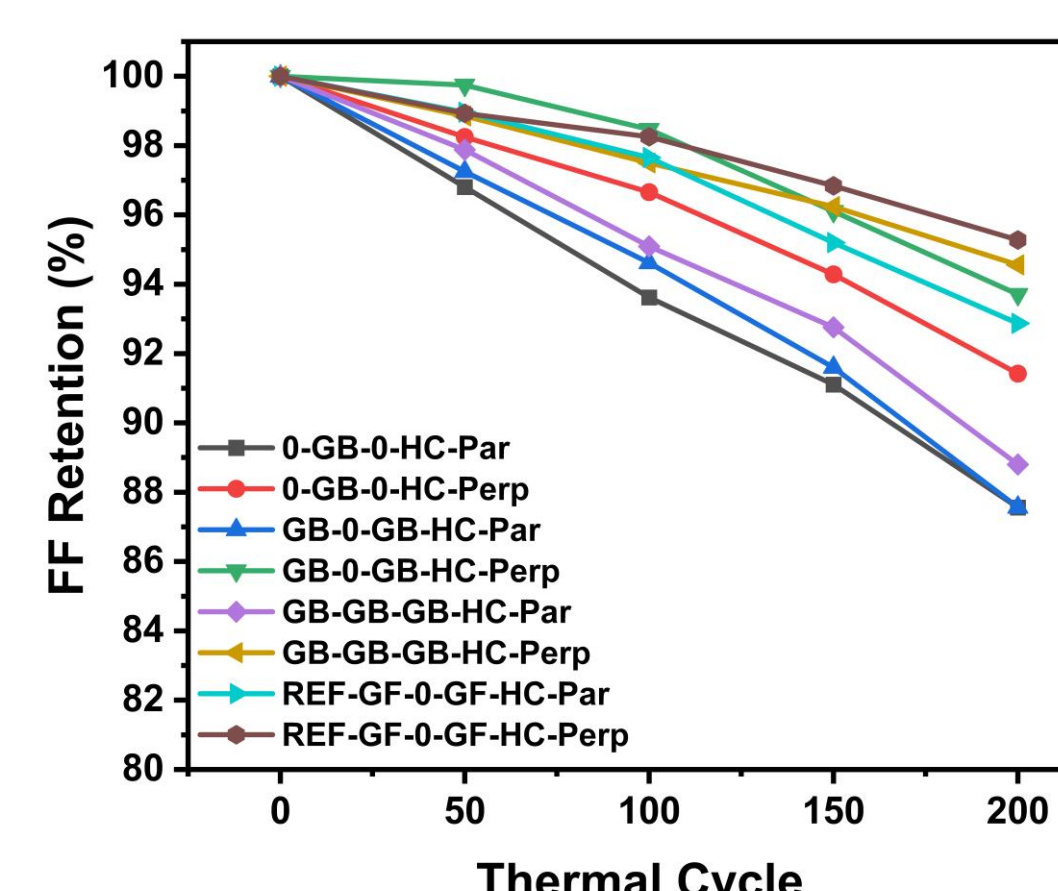
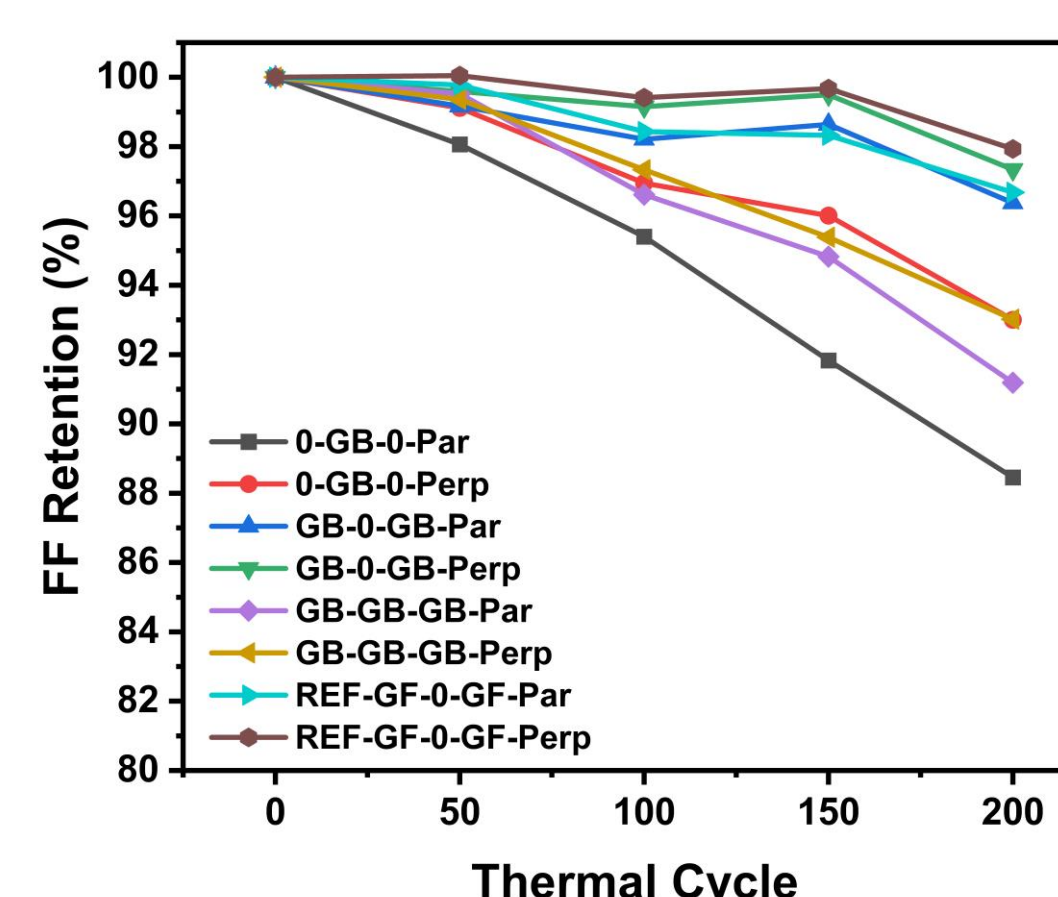


Methodology

- Manufactured mini-modules using full and cut M2 SHJ cells.
- Carrier foils with GF and various GB configurations were used.
- Monitored module performance (IV, EL).



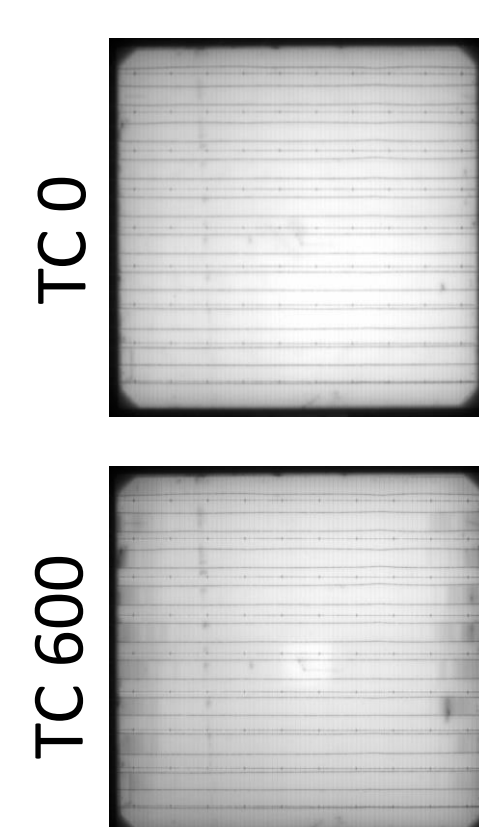
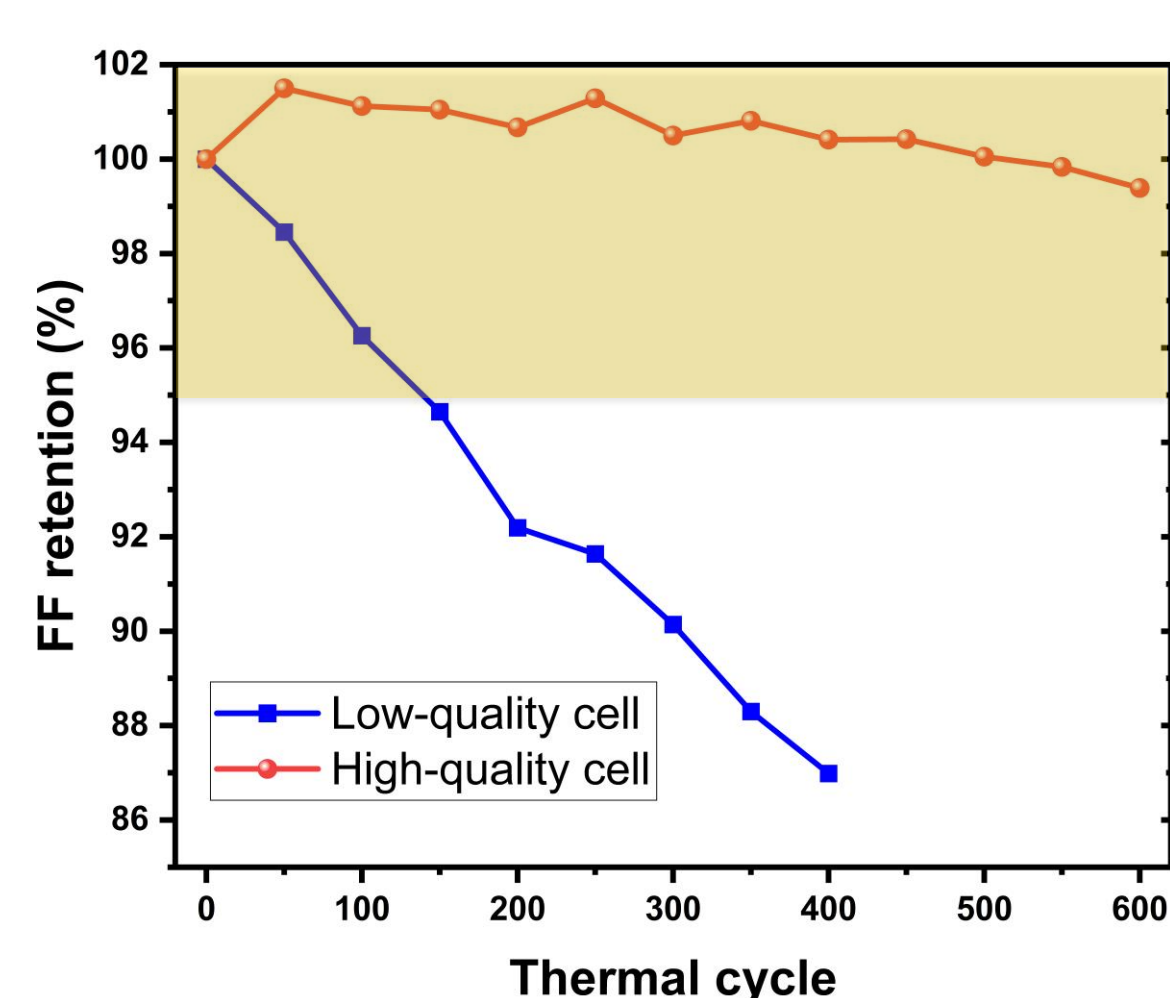
Results



Modules	TC	Perpendicular	Parallel	Perpendicular	Parallel
REF GF-0-GF	0				
	200				
GB-0-GB	0				
	200				
GB-GB-GB	0				
	200				
0-GB-0	0				
	200				

Validation Results

- TWILL modules with high-quality cells showed excellent reliability.



Conclusions

- Perpendicular Cu wire orientation consistently improved FF retention.
- GF-reinforced foils showed better reliability than GB-reinforced foils.
- Incorporation of GB in outer layers of carrier foils improved durability.
- Material choice and wire orientation are key to optimizing TWILL interconnection.

Acknowledgments

- ❖ SiLEAN project has received funding from the European Union's Horizon Europe research and innovation Programme under GA No. 101147275
- ❖ SHINE PV project has received funding from the European Union's Horizon Europe research and innovation programme under GA No 101172902

